Time Orientation and Human Performance

Yan Zhang [a], Ravindra S. Goonetilleke [a], Thomas Plocher [b], and Sheau-Farn Max Liang [c]

[a] Dept. of Industrial Engineering & Engineering Management,
Hong Kong University of Science & Technology, Hong Kong.
[b] Honeywell Laboratories, Minneapolis, USA.
[c] Dept. of Industrial Engineering & Management, National Taipei University of Technology, Taiwan, ROC.

Abstract. Time orientation, which categorizes behaviors as monochronic or polychronic, is potentially an important consideration as it can influence the manner in which an operator interacts with complex systems. Differences among cultures have already been shown using measurement scales such as the Modified Polychronic Attitude Index 3 (MPAI3) and the Inventory of Polychronic Values (IPV). This paper is an attempt to show further differences between the two groups and present a hypothetical model for the potential causes of these differences using performance resource functions.

Keywords. Time orientation, Time sharing, Individual differences, Multi-tasking.

1. Introduction

With increased globalization, understanding the various cultures and people's attitudes and behaviours is crucial for business and product success. Hall (1989) proposed three concepts to account for cultural differences among people: time, context, and space. Differences in time orientation have been cited for a long time but have gained prominence only in the recent past. The two extreme ways of handling different tasks have been labeled by Hall (1959; 1983; 1990) as monochronicity (M) and polychronicity (P). Monochronicity or monochronic behaviour is characterized by a person doing one thing at a time, while polychronicity refers to behavior that attempts to do many things at a time. A person exhibiting monochronic behaviour, also known as a monochron, is generally very focused on one task at a time and dislikes interruptions, as that will tend to affect their concentration on that task (Hall and Hall, 1990). They also tend to work on a systematic schedule with rather well-defined priorities. On the other hand, a polychron can be very distracted by the heaps of information around them, the lack of which may result in boredom. Cotte and Ratneshwar (1999) have given a mathematical analogy by stating that monochrons consider time as linear and separable into small units, whereas polychrons consider time as naturally recurring and thereby using it as and when needed to attend to the many different tasks they face.

Due to the potential differences between the two types of behaviour and its importance in our daily lives, many researchers have investigated and proposed ways to measure and quantify time orientation. These include the polychronic Attitude Index (PAI) proposed by Kaufman et al. (1991), Polychronic Attitude Index 3 (PAI3) proposed by Kaufman-Scarborough and Lindquist (1999), Modified Polychronic Attitude Index 3 (MPAI3) proposed by Lindquist et al. (2001), and Inventory of Polychronic Values (IPV) proposed by Bluedorn et al. (1999). In general, rating scales should have alpha coefficients greater than 0.8 if they are to have sufficient internal consistency (Nunnally, 1978). The MPAI3 and IPV scales have shown promise due to their relatively high internal consistency. The Cronbach's alpha for the MPAI3 scale has been shown to be 0.88 for American males (Lindquist et al., 2001) while a coefficient of 0.86 has been obtained with US senior business majors for the IPV scale (Bluedorn et al., 1999). Even though there are sufficient means to elucidate the time orientation of people, there seems to be insufficient research to show the relationship between time orientation and the actions or performances of people (Kaufman-Scarborough and Lindquist, 1999). A somewhat restrictive study was performed by Waller et al. (1999) with 26 groups of 3 to 4 people, where they found that an individual's time urgency increased the group's monochronic behaviour and had a positive effect on the group's primary task activity.

The objective of this paper is to show some of the effects of time orientation on multitasking performance and discuss potential reasons for some of the underlying differences.

2. M/P effects on human performance

With varying task arrival rates and the two extremes of time orientation, it appears that there are four discrete possibilities: a monochron attending to one thing at a time or attempting many things at a time and a polychron attending to one thing at a time or many things at a time. Such scenarios arise when tasks arrive in a regular way and the sequences are predictable or when tasks appear in some irregular fashion or with some unexpected schedule. Lee (1999) mentioned a potential conflict when monochrons attempt to handle tasks that arrive in a continuous fashion as they may get disoriented when facing multiple tasks (Hall, 1990). We believe that a polychron attending to just one task, may also encounter problems as it may give rise to boredom and thereby possibly affecting overall performance, as polychrons are known to

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
00 JUN 2004	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Time Orientation and Human Performance	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Dept. of Industrial Engineering & Engineering Management, Hong Kong University of Science & Technology, Hong Kong; Honeywell Laboratories, Minneapolis, USA**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM001766, Work with Computing Systems 2004 (Proceedings of the 7th International Conference).

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**5**	

manage interruptions, activity switches, and job uncertainty and pressure quite well (Kaufman-Scarborough and Lindquist, 1999).

Zhang et al. (2003b) have verified some of the previous claims in relation to monochrons and polychrons by having participants perform a complex dual-process control task using the Control Station software (Cooper and Dougherty, 2001). The MPAI3 questionnaire was used to assess time orientation quantitatively. The experimental results showed that there were significant differences in performance as well as strategy between monochrons and polychrons. Monochrons had a tendency to control the two processes sequentially, while polychrons attempted to control both processes by flip-flopping between the two. As a result, polychrons had significantly more number of switches between the two processes and better performances than monochrons.

Much more work is needed to determine the task difficulty thresholds at which monochrons differ from their counterparts, and under what conditions the strategy or behaviours of any one group will change and how. Some of the factors that influence a person's time orientation may give some cues as to how time orientation affects human performance.

3. Factors influencing M/P behavior

Culture, social and work groups, one's personality (Cotte and Ratneshwar, 1999) and the nature of the task at hand (Hall, 1983; Kaufman et al., 1991) can contribute towards an individual's time orientation and behaviour.

3.1. Culture

Research has shown that people of different cultures organize their time and behaviour in different ways. For example, North-American, Northern and Central European nationals are said to have a monochronic perception of time, whereas Mediterranean, South-American, African and Asian nationals are seen as polychronic individuals (Kvassov and Tetard, 2000). The need for monochronicity is somewhat backed by common phrases such as 'now is not the time for that' or 'do one thing at a time'. Furthermore, Lindquist et al. (2001) using the MPAI3 found that Japanese students were significantly more monochronic than their American counterparts. In many Latin American cultures that show polychronic tendencies, people conduct many business meetings at once, extending the time that each may take. This is an example of how culture works to influence the individual's orientation towards monochronic or polychronic behavior.

Zhang et al. (2003a), have shown that there were significant differences between Americans and Chinese, but no significant difference between Mainland Chinese and Hong Kong Chinese when the behaviour was evaluated using the MPAI3 and IPV scales. They have shown that, even though cultural variations seem to be significant, there are large variations within any one culture. In other words, the exceptions (i.e., individuals) to the norm (that is, culture) can be quite significant (see standard deviations in Figure 1).

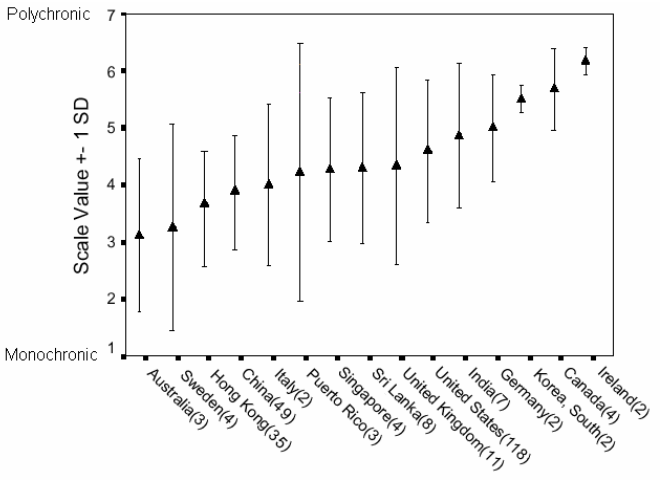

Figure 1. Mean ± standard deviation of MPAI3 scores for different birth nationalities

3.2. Social and work groups

Manrai and Manrai (1995), Cotte and Ratneshwar (1999) have mentioned the existence of monochrons and polychrons within one culture. They attributed the difference to social and work groups such as family, peer groups, and work groups (McGrath and Kelly, 1986). In some of the work that people perform, they may have to do many tasks at the same time. Examples include those who work in express package companies, hospitals, travel agencies and so on. Individuals within a work group, industry or company have to be able to communicate with each other in some way, most of which comes through training and experience. When individuals start working together, they develop a common understanding and a group-behavior such as "polychronic behavior signifies hard work" or "polychronic behavior means chaos and frustration" (Cotte and Ratneshwar, 1999) so that the group requirements may affect an individual's or even a work-group's behaviour as found by Waller et al. (1999).

3.3. Individual characteristics

Kaufman et al. (1991), using the PAI scale, found that polychronic time was positively correlated with education (that is, those with higher education tend to be more polychronic), employment, social group and club membership, but not correlated with gender, age, income, or marital status even though Hall (1983) has argued that monochronic time tends to be male-time, while females tend to show more polychronic tendencies. Moreover, Francis-Smythe and Robertson (1999) showed that younger people are more polychronic than older people and job nature had a significant effect on polychronicity. Similarly, Ellis et al. (1996), have found that younger adults are able to develop parallel processing capability, while older adults remain serial processors in visual information processing tasks indicating an age relationship to processing ability and thus task performance.

Researchers have used information overload to explain some of the differences between monochrons and polychrons. Haase et al. (1979) defined polychronicity as "the ability to cope with stimulus-intense, information-overload environments". They developed a 25-item scale that was reduced to five orthogonal factors: information overload,

interpersonal overload, change overload, activity structure, and temporal structure. They concluded that cognitively simple people (Bieri et al., 1966) regulate their input to avoid overload, especially when they are bombarded with information. They did not find a direct relation of cognitive complexity with a person's polychronicity but they did find a significant correlation ($r = -0.42$) between cognitive complexity and temporal structure of the 5-factor scale. Frei et al. (1999) believe that M/P behavior is related to the time-sharing ability of individuals and hence it is no surprise that time orientation has been somewhat clouded by the vast amount of human factors research related to time-sharing.

If information processing abilities is the root cause of the differing time orientations among people, it may be hypothesized that cognitive styles and abilities may be related to M/P behaviour. We investigated the relationship between time orientation, cognitive styles and cognitive ability in a 48-person experiment. Cognitive style was measured using the Wholist-Analytic and the Verbal-Imagery scores of the Cognitive Style Analysis -CSA (Riding and Rayner, 2000). Industrial Psychology International (IPI) has designed standardized tests for employee evaluation that have reasonable reliability and validity over large numbers of differing samples. Hence, the IPI perception, memory and judgment tests were used in the experiment. The perception test measures one's ability to locate details and to recognize differences quickly. The memory test was used as it can measure recognition and recall of visual, verbal and numerical information. The judgment test has been designed to evaluate the aptitude to think logically and measure the ability to determine solutions to abstract problems. In addition, a digit span test (Goonetilleke et al., 1999) was designed to check the number of digits a person can reliably remember within a short time. The Hirshkowitz et al. (1993) vigilance task was used to measure the participant attention for a period of 15 minutes when each participant was listening to English news through headphones (distraction). The participants were told that their main task was to respond correctly to the attention task and they were told that they would not be questioned on the news that they heard. Twenty-four monochrons (M) and 24 polychrons (P) were selected based on their MPAI3 (Lindquist et al., 2001) and IPV (Bluedorn et al., 1999) scale scores. The ANOVA showed that there were no significant ($p < 0.05$) differences between the M and P group for perception, judgment, memory and cognitive styles. However, the ANOVA results showed that there were significant differences between the M and P groups in the attention test. The monochrons had a significantly higher number of hits than the polychrons ($F(1,44)=4.11$, $p=0.0488$). This result is reasonable as monochrons are able to concentrate on one thing (Hall, 1990) without being distracted by the news. On the other hand, a polychron, is somewhat easily distracted and are able to cope with interruptions (Hall and Hall, 1990). Thus, it may be presumed that the "background" English news may have distracted the polychrons and resulted in a somewhat poorer performance in their attention test.

The fact that there are differences in attention, even though there aren't any differences in the important cognitive abilities related to information processing, seem to indicate that monochrons and polychrons may be using differing resource allocation strategies and the concept of performance resource function (PRF) (Norman and Bobrow, 1975) may be useful to explain some of the findings. Wickens and Hollands (2000) have illustrated how the performance of one task would deteriorate in the presence of a second task using PRFs. Even though the task may not be demanding, the allocation of resources by an individual will govern the performance in each task. It may be hypothesized that monochrons allocated more resources on the attention task and neglected what they heard through headphones (second task), while polychrons were "dragged" into the interruptive news that they heard thereby lowering their number of hits on the attention task. In this experiment, the participants were clearly told the importance of the two tasks. However, more research is needed to understand what might happen in situations where all tasks have equal importance or a range of differing difficulties.

3.4. Tasks

Monochronic behavior dominates the official worlds of business, government, the professions, entertainment, and sports (Hall, 1983). However, polychronic behavior tends to be the norm for household activities (Hall, 1983). This implies that task difficulty plays a large role in doing many things or one thing at a time. In order to determine this effect, we conducted a study where participants were requested to perform two different tasks (math calculations on paper and visual search on a computer monitor) under three different conditions:

1. task sequencing by participants under self-paced conditions
2. task sequencing by participant but under paced conditions and
3. both tasks presented together under paced conditions.

The effects of M/P, culture (Hong Kong Chinese and Mainland Chinese), task condition and their interactions were investigated. The results showed that time orientation, culture, and task condition had significant ($p < 0.05$) effects on behavior and performance. In general, polychrons switched more number of times between the two tasks than monochrons ($F(1,132)=5.44$, $p=0.0212$). The number of switches between the two tasks was greatest in condition 3 for both monochrons and polychrons. These results may be due to individuals being motivated to perform multiple tasks at the same time when there are tight schedules (Wright, 1988). The performance results showed that polychrons had higher accuracy than monochrons for the search and math calculation tasks when there was time pressure. There were no performance differences between monochrons and polychrons under the self-paced conditions (condition 1). Thus, it appears that pacing seems to influence M/P performance. The results also showed that there were significant differences in performance between the monochrons and polychrons from Mainland China, but not so for Hong Kong Chinese. Since the performance of Mainland Chinese was significantly better than that of Hong Kong Chinese, especially for the math calculations ($F(1,132)=20.60$, $p<0.0001$), the task difficulty level may be different for the two populations and this may have been the cause for the difference between monochrons and polychrons. Since there were significant interactions

between M/P and the three conditions for Mainland Chinese, simple effects analyses were performed that showed no difference between monochrons and polychrons from Mainland China for the self-paced condition. However, there were significant performance differences between monochrons and polychrons in the two paced conditions. This study shows that task difficulty and time pressure could have different effects on monochrons and polychrons. Based on these results, it may be hypothesized that there are no performance differences between monochrons and polychrons for relatively easy tasks or very difficult tasks. In other words, there are two potential thresholds: a simplicity threshold and a difficulty threshold. Differences between the two groups may only be present between the two thresholds. Further study is needed to validate these claims and to determine these thresholds.

4. Implications

The two extreme types of behaviour can have important implications for product and system design. For example, a polychronic person may be bored attending to one task with any one device. But, if these "personal appliances" can allow a person to do more than one task at a time, polychrons may be able to keep their attention on different tasks while performing each task better than just one.

The differences between the two groups also have implications on software and operating system (OS) design. For example, the windows platform is ideally suited for polychrons as they are able to switch easily between different tasks. When a task difficulty increases, the system allows the user to close the unnecessary or annoying tasks (such as those that beep when an email arrives) quite easily. Similarly, monochrons are able to function as they wish with just one task at a time.

For supervisory control situations with very stable and reliable control systems, it may be hypothesized that a monochron may be more suitable as they will not "enter" the control loop, unlike a polychron who may have a greater tendency to enter into-the-control-loop at regular intervals to maintain their vigilance levels. Even in airplanes, there may be differences in the way that polychron and monochron pilots use features such as the "auto-pilot".

Previous research has shown that the performance of routine and monotonous tasks can be improved with music while music may have an adverse effect for more complex tasks. In such situations, it will be useful to determine whether there are any differences between monochrons and polychrons knowing that the behaviour of these two groups are quite different depending on task difficulty.

5. Summary

This paper has introduced the concept of time orientation and has attempted to show possible differences between monochrons and polychrons attending to different tasks. Further study is needed in order to quantify the resource allocation strategy considering the different task characteristics so that a predictive model can be generated for the two groups.

6. Acknowledgement

The studies reported here were funded by Honeywell Laboratories and a Direct Allocation Grant (DAG03/04.EG15) from HKUST.

7. References

Bieri, J., Atkins, A.L., Briar, S., Leaman, R.L., Miller, H., & Tripodi, T. (1966). *Clinical and social judgment: the discrimination of behavioral information*. New York: Wiley.

Bluedorn, A.C., Kalliath, T.J., Strube, M.J., & Martin, G.D. (1999). Polychronicity and the Inventory of Polychronic Values (IPV): The development of an instrument to measure a fundamental dimension of organizational culture. *Journal of Managerial Psychology, 14(3-4),* 205-230.

Cooper, D., & Dougherty, D. (2001). Control station: an interactive simulator for process control education. *International Journal of Engineering Education, 17 (3).* 276- 287.

Cotte, J., & Ratneshwar, S. (1999). Juggling and hopping: What does it mean to work polychronically? *Journal of Managerial Psychology, 14(3-4),* 184-204.

Ellis, R.D., Goldberg, J.H., & Detweiler, M.C. (1996). Predicting age-related differences in visual information processing using a two-stage queuing model. *Journal of Gerontology: Psychological Sciences, 51B(3),* 155-165.

Francis-Smythe, J., & Robertson, I. (1999). Time-related individual differences. *Time and Society, 8(2),* 273-292.

Frei, R.L., Racicot, B., & Travagline, A. (1999). The impact of monochronic and Type A behavior patterns on research productivity and stress. *Journal of Managerial Psychology, 14(5),* 374-387.

Goonetilleke, R. S., Shih, H. M., & Sze, Y. Y. (1999). Memory span: the effect of calculation method and presentation mode. *International Journal of Cognitive Ergonomics, 3(4),* 271-287.

Graham, R.J. (1981). The role of perception of time in consumer research. *Journal of Consumer Research, 7(4),* 335-342.

Haase, R.F., Lee, D.Y., & Banks, D.L. (1979). Cognitive correlates of polychronicity. *Perceptual and Motor Skills, 49,* 271-282.

Hall, E.T. (1959). *The silent language.* New York: Fawcett Publications.

Hall, E.T. (1983). *The dance of life: the other dimension of time.* New York: Anchor Press.

Hall, E.T. (1989). *Beyond culture.* New York: Anchor Press.

Hall, E.T. (1990). *The hidden dimension.* New York: Anchor Press.

Hall, E.T., & Hall, M.R. (1990). *Understanding cultural differences.* Yarmouth, Me: Intercultural Press.

Hirshkowitz M., De la Cueva L., & Herman J.H. (1993). The multiple vigilance test. *Behavior Research Methods, Instruments, and Computers, 25(2),* 272-275.

Kaufman, C.F., Lane, P.M., & Lindquist, J.D. (1991). Exploring more than 24 hours a day: A preliminary investigation of polychronic time use. *Journal of Consumer Research, 18(3),* 392-401.

Kaufman-Scarborough, C., & Lindquist, J.D. (1999). Time management and polychronicity: Comparisons, contrasts, and insights for the workplace. *Journal of Managerial Psychology, 14(3-4),* 288-312.

Kvassov, V., & Tetard, F. (2000). Impacts of information technology on temporal dimensions of managerial work and its productivity. *Proceedings of 5-th AIM conference.* Montpellier, France.

Lee, H. (1999). Time and information technology: monochronicity, polychronicity and temporal symmetry. *European Journal of Information Systems, 8,* 16–26.

Lindquist, J.D., Knieling, J., & Kaufman-Scarborough, C. (2001). Polychonicity and consumer behavior outcomes among Japanese and U.S. students: A study of response to culture in a U.S. university setting. *Proceedings of the Tenth Biennial World Marketing Congress*. City Hall Cardiff, UK.

Manrai, L.A., & Manrai, A.K. (1995). Effects of cultural-context, gender, and acculturation on perceptions of work versus social/leisure time usage. *Journal of Business Research, 32,* 115-128.

McGrath, J.E., & Kelly, J.R. (1986). *Time and human interaction: Toward a social psychology of time.* New York: Guilford Press.

Norman, D., & Bobrow, D. (1975). One data-limited and resource-limited processing. *Journal of Cognitive Psychology, 7,* 44-60.

Nunnally, J.C. (1978). *Psychometric theory*. New York: McGraw-Hill.

Persing, D.L. (1999). Managing in polychronic times: Exploring individual creativity and performance in intellectually intensive venues. *Journal of Managerial Psychology, 14(5),* 358-373.

Riding, R.J., & Rayner, S.G. (2000). *Cognitive styles.* Stamford, Conn.: Ablex Publishing Corp.

Schein, E.H. (1992). *Organizational culture and leadership* (2nd Edition). San Francisco: Jossey-Bass Publishers.

Waller, M.J., Giambatista, R.C., & Zellmer-Bruhn, M.E. (1999). The effects of individual time urgency on group polychronicity. *Journal of Managerial Psychology, 14(3-4),* 244-256.

Wickens, C.D., & Hollands, J.G. (2000). *Engineering psychology and human performance*. Upper Saddle River, New Jersey: Prentice-Hall Inc.

Zhang Y., Goonetilleke, R.S., Plocher, T., & Liang, S. F. (2003a). Should we worry about the time orientation of cultures when designing systems? *Proceedings of the IEA 2003 XVth Triennial Congress. Seoul, Korea.*

Zhang Y., Goonetilleke, R.S., Plocher, T., & Liang, S. F. (2003b). Time orientation effects on process control. *Proceedings of the IEA 2003 XVth Triennial Congress. Seoul, Korea*.